Y-Stent-Assisted Coil Embolization of Anterior Circulation Aneurysms Using Two Solitaire AB Devices: a Single Center Experience

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Key words: wide-neck aneurysm, embolization, Y-stenting technique, closed-cells stent

Summary

Wide-neck intracranial aneurysms remain a challenge to endovascular treatment. We describe our experience in repairing wide-neck aneurysms of the anterior circulation located at arterial branch points using coil embolization assisted by Y-stenting using two Solitaire® stents.

Six wide-neck intracranial aneurysms located on the middle cerebral artery bifurcation [3], pericallosal artery [1], and anterior communicating artery [2] were repaired by Y-stent-assisted coil embolization using two Solitaire® stents. Four cases were incidental findings of aneurysm and two cases were previously treated ruptured aneurysms that had undergone recanalization.

All the cases were successfully treated without complications. Follow-up by digital subtraction angiography and magnetic resonance angiography at six months showed the stents to be patent with no recanalization of the aneurysm sacs.

Repairing wide-neck aneurysms of the anterior circulation by Y-stent-assisted coil embolization using two Solitaire® stents is a simple and safe method of treating complex aneurysms. While the results are promising, larger series with longer term follow-ups are needed to corroborate that this treatment method is superior to other techniques.

Abbreviations

ACOA: *anterior communicating artery*;
DSA: *digital subtraction angiography*;
ICA: *internal carotid artery*;
MCA: *middle cerebral artery bifurcation*;
MRA: *magnetic resonance angiogram*;
MRI: *magnetic resonance imaging*;
PA: *pericallosal artery*;
TOF: *time-of-flight*.

Introduction

Endovascular remodeling of intracranial aneurysms has made giant strides forward in recent years with the introduction of new materials, making it possible now to treat complex aneurysms, achieving satisfactory outcomes at relatively low levels of risk. Wide-neck aneurysms, defined as aneurysms having a neck diameter greater than 4 mm or a sac-to-neck ratio of less than 2 mm, remain a challenge to endovascular repair, primarily because of the difficulty in keeping the coils inside the aneurysm sac and the high risk of recanalization [1,2].

Embolization of wide-neck bifurcation aneurysms is particularly difficult, and the literature describes several series of coil embolization assisted by placement of stents in a Y configuration to prevent occlusion of the efferent arteries secondary to coil migration. In some published cases at least one of the stents has been an open-cell stent [3,4] but in other cases of Y-stent-assisted coil embolization two closed-cell stents have been used [5-7], yielding the same success and efficacy rates and similar risk rates.

The Solitaire® stent (ev3, Plymouth, MN, USA) is a fully retrievable, self-expanding, closed-cell nitinol stent designed to treat intracranial aneurysms [8-12]. Use of this type of stent in Y-stent-assisted treatment of wide-neck aneurysms of the posterior circulation has been described [11].

We describe a series of six cases of Y-stent-assisted remodeling of wide-neck intracranial aneurysms located at arterial bifurcations of the anterior circulation [middle cerebral artery [3], pericallosal artery [1], and anterior communicating artery [2]] using two Solitaire® stents, with good outcomes.

Materials and Methods

Six patients were treated, five women and one man, ranging from 39 to 80 years of age. Four of the six cases were unruptured aneurysms detected incidentally on MRI for other causes (one had previously undergone coil embolization followed by recanalization), and two cases were previously treated ruptured aneurysms that had undergone recanalization. One of the latter two cases had been treated by clipping, the other by coil embolization (Table 1).

Dual antiplatelet therapy (Adiro 100 mg/d and Plavix 75 mg/d) was administered to all the patients during the three days previous to intervention. Procedures were performed under general anesthesia in the digital angiography room (Integris V3000, Philips, Best, The Netherlands).

Following a bilateral femoral approach, an initial dose of heparin (5 000 U) was administered. The cervical internal carotid artery (ICA) ipsilateral to the aneurysm was catheterized using two Envoy® 6F (Envoy; Cordis, Bridgewater, New Jersey, USA) guiding catheters. A 3D rotational angiographic imaging study was carried out through one of the catheters to accurately measure aneurysm and neck diameter, the parent artery leading to the aneurysm, and the efferent arteries leading away (Figure 1A).

Following road mapping using the working projection, the first maneuver was to position the distal tip of the first stent in the efferent artery that was more difficult to catheterize (having a more angular origin) (Figure 1B). Next, the second stent was inserted across the first until its distal tip was positioned in the more negotiable efferent artery (Figures 1C, 2B, 3). Both branches were catheterized first with an Excelsior® Sl-10 microcatheter (90º or 45º curve) (Target Therapeutics/Boston Scientific, Fremont, CA, USA) over a Traxcess® 0.014-inch microguidewire (MicroVention, Tustin, CA, USA). Afterwards, the guidewire was exchanged for a Transend® 300 cm (Boston Scientific) guidewire, and the delivery microcatheter (Rebar® 18, ev3, Plymouth, MN, USA) was advanced to the desired position. When positioned, the guidewire was withdrawn and the Solitaire®-stent was slowly inserted through the delivery microcatheter.

In all cases the aim was not to detach the stents until after they had been deployed in the Y configuration, and this maneuver enabled us to stabilize the position of both stents and avoid unnecessary motion when the delivery microcatheter for the second stent was

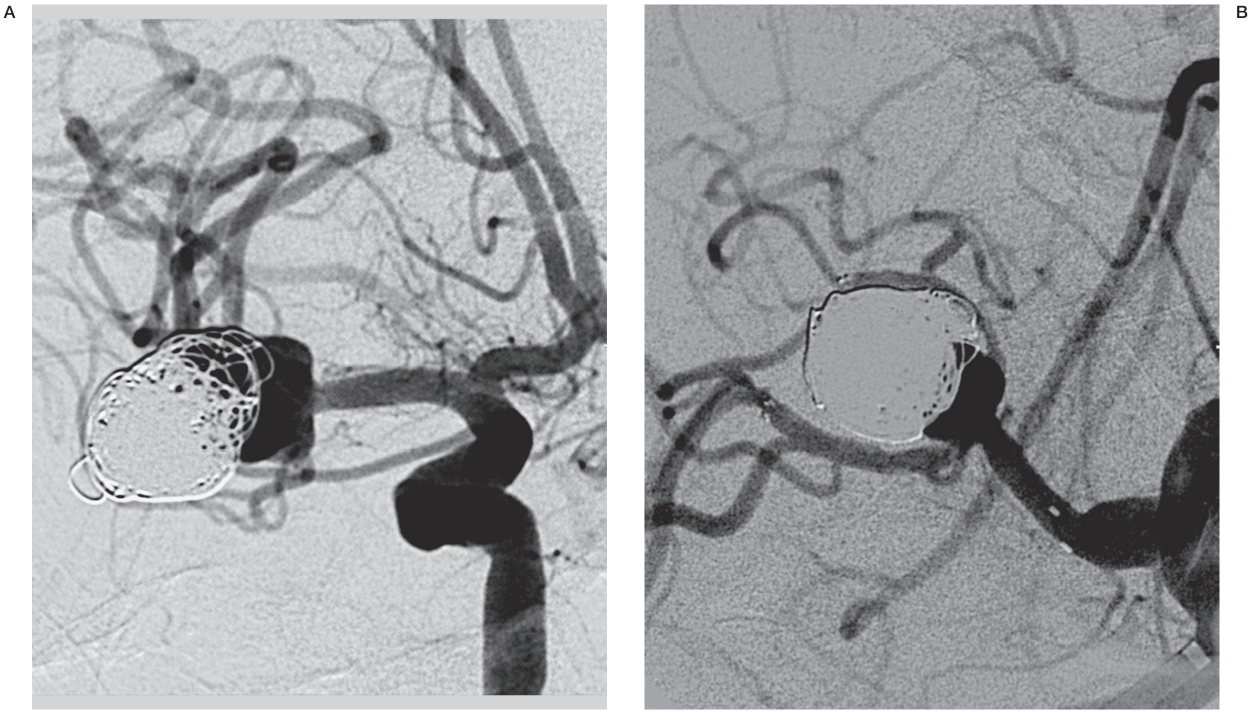
Table 1

A/S	L	P	SS (mm)	OR	F	S/N (mm)	mRS
80/M	MCA	RAC/INC	4×20 & 4×20	1	1	Giant/ 8	0
47/F	MCA	INC	4×20 & 4×20	2	2	Giant/ 9	0
39/F	PA	INC	4×20 & 4×20	1	1	6/5	0
50/F	ACOA	RACL	4×20 & 4×20	1	1	5/4	0
57/F	MCA	RAC	4×20 & 3×20	1	1	18/9	0
44/F	ACOA	INC	4×20 & 4×20	1	1	5/4	0

Abbreviations: A/S: *Age / Sex.* L: *Location.* MCA: *Middle cerebral artery.* PA: *Pericallosal artery.* ACOA: *Anterior communicating artery.* P: *Presentation.* Inc: *Incidental.* RAC: *Recanalization after coiling.* RACL: *Recanalization after clipping.* SS: *Stent size.* OR: *Occlusion rate (Raymond Scale).* 1: *Complete occlusion,* 2: *Neck remnant,* 3: *Residual aneurysm.* F: *Six-month follow-up occlusion rate (MRA and DSA).* S/N: *Aneurysm size/neck diameter.* Giant: *Greater than 25 mm.* mRS: *Modified Rankin Scale.* 0 = *No symptoms at all.* 1 = *No significant disability despite symptoms; able to carry out all usual duties and activities.* 2 = *Slight disability; unable to carry out all previous activities but able to look after own affairs without assistance.* 3 = *Moderate disability requiring some help but able to walk without assistance.* 4 = *Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance.* 5 = *Severe disability; bedridden, incontinent, and requiring constant nursing care and attention.*

Figure 1 A) 3D rotational angiography: wide-neck aneurysm located at the bifurcation of the pericallosal artery in a patient with an azygos anterior cerebral artery. B) Following a study of the aneurysm morphology, the first Solitaire® stent (4 × 20 mm) is positioned in the more highly curved branch. C) With the first stent in position, the second Solitaire® stent (4 × 20 mm) is deployed, yielding a Y configuration. D) The two stents are detached and coil embolization of the aneurysm sac is performed without complication.

pushed through the cells of the first stent (Figures 1C, 2B, 3). After the stents had been detached electrolytically, one of the Envoy® 6F guiding catheters was withdrawn. The aneurysm sac was then catheterized with a Traxcess® 14 microguidewire and an Excelsior® Sl-10 (45º curve) microcatheter through the other catheter positioned in the ICA traversing the cells of both stents, and coil embolization was performed (Figure 1D, 2C, 3B).



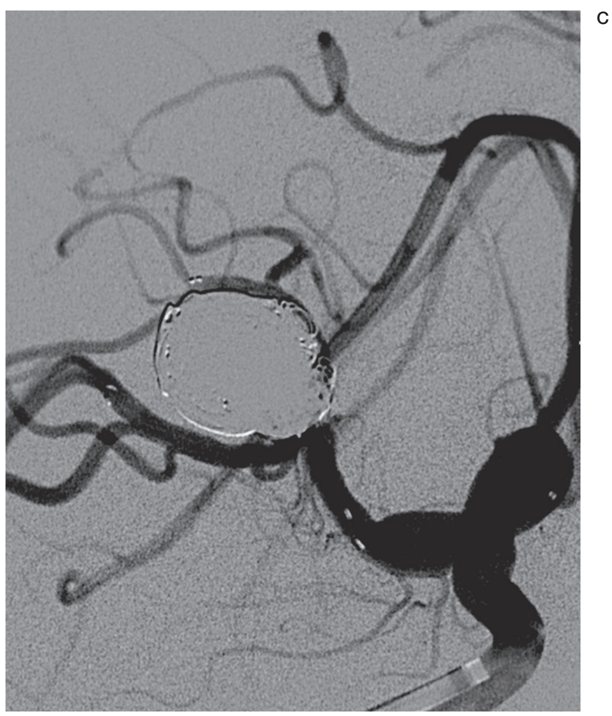


Figure 2 A) Recanalized aneurysm at the bifurcation of the MCA; the aneurysm had previously been coil embolized. B) The two stents pass through each other without difficulty, protecting both branches of the MCA distal to the aneurysm. C) With the stents in place, coil embolization results in complete occlusion of the aneurysm sac.

Results

All six procedures were completed successfully without complication, achieving complete occlusion in five and subtotal occlusion (neck remnant) in one as measured by the Raymond Scale [13]. There were no instances of displacement of the stents when the microcatheters were pushed through their cells, and coiling did not result in stenosis of the stents, nor did the

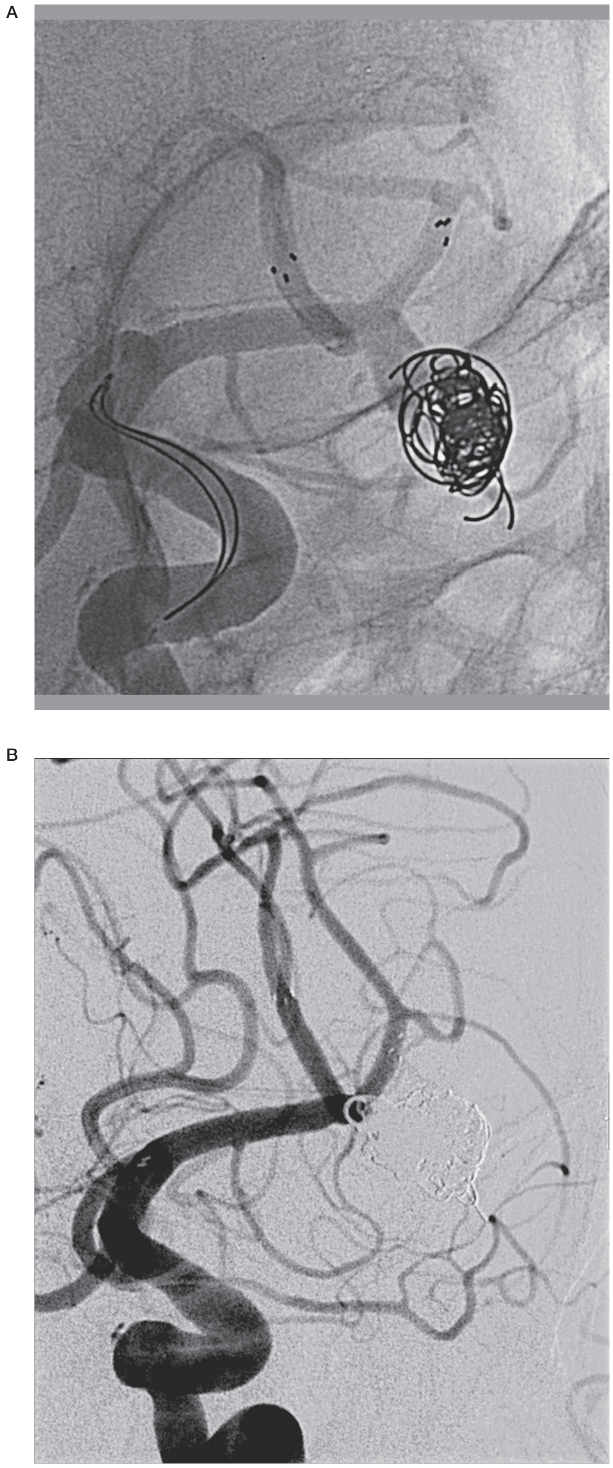


Figure 3 A) DSA. Recanalized aneurysm at the bifurcation of the MCA; the aneurysm had previously been embolized using coils.The advantage compared to other devices is that both stents can be positioned without having to be detached, and hence they may be repositioned if the first stent is dislodged when the second stent is passed through the cells of the first. B)After the detachment of the stents coil embolization was successfully achieved.

coils migrate through the cells. No arterial spasm, rupture, or thromboembolic complications occurred in any of the cases.. All the patients were awakened two hours afterwards, hemodynamically stable and free of focal neurological deficits. Patients were discharged four days later on a regimen of dual antiplatelet therapy for six months.

Follow-up took place at six months and consisted of digital subtraction angiography, magnetic resonance angiography and a neurological examination. Follow-up imaging did not reveal recanalization of the aneurysms or stent stenosis, and the efferent arteries remained patent. TOF MRI was affected by a ferromagnetic artifact at the proximal end of the stent (where it had been attached to the pusher catheter) which did not prevent visualization of the aneurysm sac, the distal ends of the stents, or the efferent arteries.

Discussion

The use of intracranial stents in treating vascular pathologies of the brain is growing increasingly commonplace in ordinary practice at interventional neuroradiology units.

These devices are beneficial not only because they prevent migration of the coils in the case of wide-neck aneurysms but also because they can be used to remodel the parent artery and alter the hemodynamics of arterial flow [14].

Some series reported in the literature used at least one of the stents in Y-stent-assisted wide-neck arterial bifurcation aneurysm repair was an open cell stent [3,4]. Reported cases of Y-stenting using closed cell stents in the anterior circulation involved Enterprise® stents (Cordis Endovascular; Miami Lakes, FL, USA) [5,6,7], while reported cases using the Solitaire® stent have involved aneurysms of the posterior fossa [11].

Since the Solitaire® stent was first described [15], promising results have been reported thanks to certain major advantages of this stent compared with other commercially available intracranial stents, namely, it is fully retrievable and self-expanding while affording high radial strength, good wall apposition, and good maneuverability [16]. Its inherent attributes and the wide range of available sizes mean that this stent can be inserted into even small arteries like the pericallosal artery [8].

Follow-up in our series was performed by digital subtraction angiography and magnetic resonance angiography at six months and in all cases showed the patency rate of the stents and the occlusion rate of the coil-embolized aneurysm sacs to be angiographically stable. TOF MRI displayed a paramagnetic artifact at the proximal end of the stent where it had been attached to the pusher catheter [12] which only hindered visualization of the proximal section of the parent artery, with visualization of the aneurysm sacs, the distal ends of the stents, and the efferent arteries being unimpeded [17].

The good results achieved in our series, together with those achieved in other similar series, suggest that this method of treatment affords a safe and simple method of repairing complex aneurysms. The results would thus appear to be promising, though larger series with longer-term follow-ups are needed to corroborate that this treatment method is superior to other techniques.

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